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Googling Crawfish Frogs: Using Satellite Imagery and Auditory Surveys to Locate Breeding Sites of a Near-threatened Species in Southernmost Illinois . . . . . John G. Palis 57

Examining the Factors That Drive Migration and Road Mortality in a Leaf-litter Snake Population (Colubridae; *Storeria*) . . . . . Iwo P. Gross 61

Pondering Poor Policy Planning, Problematic Protection, and Public Perceptions versus Proactive Programs for Marine Turtles . . . . . David S. Lee 66

What You Missed at the April Meeting . . . . . John Archer 70

Herpetology 2014 . . . . . 73

Unofficial Minutes of the CHS Board Meeting, April 18, 2014 . . . . . 75

Advertisements . . . . . 76


**Cover:** Imbabura treefrog, *Hypsiboas picturatus*, from Amazonian Ecuador. Photograph by Andrew Gilpin.


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# Googling Crawfish Frogs: Using Satellite Imagery and Auditory Surveys to Locate Breeding Sites of a Near-threatened Species in Southernmost Illinois

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**Abstract**

Crawfish frogs, *Lithobates areolatus* (formerly *Rana areolata*), are cryptic anurans that produce a loud, distinctive call that can be exploited to detect their presence during their breeding period. Crawfish frogs have declined over their entire geographic range and are classified as Near Threatened by the International Union for Conservation of Nature. Efficient methods for determining presence or absence of crawfish frogs during their brief, early-spring breeding season are needed. By modeling calling activity in relation to survey and weather variables, recent studies in Indiana have provided valuable guidance for surveying crawfish frogs. After pre-selecting survey sites using satellite imagery, I conducted an 8-night auditory survey for crawfish frogs from mid-March to early April 2014 across much of southernmost Illinois. Although visiting each site for shorter-than-recommended periods of time and often during cooler-than-recommended conditions, I heard crawfish frogs at 80 previously undetected sites. My results support the conclusions of the Indiana studies that crawfish frogs are best detected when surveys are conducted during the peak of the breeding season. My results also suggest that single, brief visits to pre-selected potential breeding sites, even at cool air temperatures, can be productive. These results potentially expand the conditions under which crawfish frog surveys can be successfully performed, thereby providing greater opportunity for crawfish frog detection during their brief breeding period.

## Introduction

Crawfish frogs, *Lithobates areolatus* (formerly *Rana areolata*), are relatively large but secretive and seldom-seen frogs (Dodd, 2013). Except during the brief, early-spring breeding season, crawfish frogs are inconspicuous, inhabiting subterranean crawfish burrows in grasslands (Heemeyer et al., 2012; Hoffman et al., 2010). Crawfish frogs breed in farm ponds and similar wetlands, particularly those that are free of predatory fishes (Palis, 2009; Phillips et al., 1999). As a result of terrestrial habitat loss due to housing and business development, modern agricultural practices, and strip mining; destruction of breeding sites; and the introduction of predatory fishes into breeding sites, crawfish frogs have declined over their entire geographic range and are classified as Near Threatened by the International Union for Conservation of Nature (Stuart et al., 2008).

In a recent status review of crawfish frogs in Indiana, Engbrecht et al. (2012) describe a considerable range contraction of the species in Indiana and suggest that, in addition to two government-owned tracts in southern Indiana and the coal spoil prairies of western Kentucky, the healthiest crawfish frog populations east of the Mississippi River are "perhaps in southern Illinois." There are no recent published occurrence data with which to refute or confirm this statement by Engbrecht et al. (2012). Based on my own informal vocalization surveys of crawfish frogs conducted intermittently since the late 1970s, it appears that crawfish frogs may be widely scattered and locally abundant in southern Illinois.

Crawfish frogs have a brief breeding period lasting ≤1.5 months, one which waxes and wanes depending upon variations in weather (Busby and Brecheisen, 1997; Williams et al., 2013). In southern Illinois, the crawfish frog breeding season typically encompasses the month of March, but may begin in late February and extend through early April (personal observations). Because large choruses typically occur on only a few nights (Busby and Brecheisen, 1997; Williams et al., 2013), an efficient means of surveying for vocalizing crawfish frogs during their abbreviated breeding season is necessary to survey large geographic areas.

Vocalization surveys are widely used to monitor and survey frog and toad populations (e.g., Dorcas et al., 2010; Weir and Mossman, 2005) including crawfish frogs (Busby and Brecheisen, 1997; Engbrecht et al., 2012; Williams et al., 2013).

Crawfish frog, *Lithobates areolatus*, from Johnson County, Illinois. Photograph by John G. Palis.

During their brief breeding season in early spring, crawfish frogs are readily detected by their loud, distinctive snore-like call (Smith, 1961). However, because the crawfish frog breeding season is so fleeting, pre-selection of potential breeding sites may help make the best use of limited time the species is readily detected. Here, I describe the use of a widely-available online resource—Google Earth—combined with auditory surveys to detect crawfish frog presence during the spring 2014 breeding season in portions of southernmost Illinois. I define southernmost Illinois as the area encompassed by the following counties: Alexander, Gallatin, Hardin, Jackson, Johnson, Massac, Pope, Pulaski, Saline, Union and Williamson.

**Survey Methodology**

My 2014 crawfish frog survey of southernmost Illinois was a three-step process. Step 1: I examined Google Earth satellite imagery—available on the internet—to locate potential crawfish frog breeding sites. I searched for ponds and wetlands that looked similar to known crawfish frog breeding sites and that occurred in agricultural settings (pastures, hayfields, fallow fields and cropfields) and in or near rural communities. I selected water bodies that appeared to be shallow and, therefore, likely fishless. Water in shallow ponds and wetlands tends to be lighter in color than deeper bodies of water. I also gave preference to relatively small ponds as they are more likely to be fishless than relatively large ponds. I searched for potential breeding sites in the vicinity of roads from which I could listen for vocalizing male crawfish frogs. I flagged potential breeding sites using the placemark feature at Google Earth and saved satellite images to my computer. I denoted locations of potential breeding sites on county maps to assist in finding pre-selected sites while afield. Step 2: I conducted nocturnal auditory surveys for calling crawfish frogs. I initiated surveys after determining that crawfish frogs had begun vocalizing. I surveyed on dry nights (i.e., not raining) after days that were relatively warm and sunny or partly cloudy. I conducted surveys by driving from wetland to wetland previously selected using Google Earth. Surveys at individual sites consisted of stopping my vehicle, lowering my windows, turning off the engine, and listening for vocalizing frogs for a minimum of one minute (stops were shortest at sites where no frog species were calling or when extraneous noises, such as the sound of traffic or nearby barking dogs, significantly interfered with my ability to hear frogs). Oftentimes, I quietly exited my vehicle and cupped my ears forward with my hands to better detect and locate provenance of calling frogs. When crawfish frogs were detected, I noted my location using road mileage from a landmark, such as a crossroad, and on field maps. In some instances I also used a Garmin Etrex Legend GPS unit to obtain geo-coordinates. I recorded a qualitative description of chorus size, identified other species of calling anurans, and recorded air temperature at my vehicle. Step 3: Using my field notes and maps, I located and determined geo-coordinates for each field-confirmed crawfish frog breeding site at Google Earth. These data are being accrued as part of an ongoing study of the current distribution and conservation status of the crawfish frog in southernmost Illinois.

**Results**

I selected 600 potential breeding sites to survey across eight southernmost Illinois counties (Jackson, Johnson, Massac, Pope, Pulaski, Saline, Union and Williamson). I surveyed on eight nights from 15 March through 1 April 2014 (Table 1). Crawfish frogs were not heard calling prior to 15 March (personal observation; Chris Evans, personal communication; Rob Stroh personal communication). My survey was interrupted by periods of cold weather, including nights having low temperatures below freezing and snowfall. Air temperatures recorded while crawfish frogs were calling (including chorusing) ranged from 1.0 to 16.5°C and winds varied from 0 to 27 km/h (Table 1). Surveys were initiated (and crawfish frogs were calling) as early as 1920 CDT and terminated (and crawfish frogs were calling) as late as 0130 CDT. The peak of crawfish frog calling appeared completed by April 1st as frogs were calling intermittently on that date and some were even calling at burrows away from breeding sites. Crawfish frogs sometimes call at burrows following breeding activity (Smith et al., 1948).

I visited approximately 220 of the 600 pre-selected sites and detected crawfish frogs in 90 breeding sites, including 80 newly documented sites. In some cases, frogs may have been calling from more than one of a cluster of ponds or wetlands. I also heard crawfish frogs vocalizing elsewhere during this survey, but was unable to determine provenance of the calls. I detected

**Table 1**. Weather variables observed before and during 2014 crawfish frog surveys. Daily maximum air temperature, and wind speed and direction during surveys are for weather stations closest to survey areas and include Cape Girardeau, Missouri; Carbondale, Illinois; and Paducah, Kentucky (obtained at www.wunderground.com). Cloud coverage before and during surveys and high and low temperatures during surveys were observed by JGP.

| Date 2014 | Sky (day / night) | Daily maximum temperature °C | Wind | | Survey air temperature | |
|---|---|---|---|---|---|---|
| | | | Speed (km/h) | Direction | High °C | Low °C |
| 15 March | clear / clear | 22.5 | 6.5–11 | SSE | 13 | 5.5 |
| 18 March | partly cloudy / clear | 14 | 13–24 | SSE | 11 | 8.5 |
| 20 March | clear / clear | 18 | 5.5–7 | SW | 11 | 1 |
| 21 March | partly cloudy / partly cloudy | 20.5 | 5.5–27 | SSW | 16.5 | 13 |
| 22 March | clear / clear | 15.5 | 9.5–14.5 | NNW | 8 | 5.5 |
| 28 March | clear / clear | 15 | 11–17 | NW | 13 | 8 |
| 30 March | clear / clear | 15 | 0–9.5 | SSW | 7 | 3.5 |
| 1 April | partly cloudy / cloudy | 20 | 0–13 | W | 14 | 11 |

crawfish frogs at 7–19 (mean = 11) breeding sites per survey-night. Number of males detected per breeding site included: 1) one male, 2) several males (non-overlapping or individually distinguishable overlapping calls), 3) a chorus of males (overlapping calls that blend together, individuals are not readily distinguished), or 4) a strong chorus of males (extremely loud chorus of overlapping calls; a "roar"). Because crawfish frog choruses at any given wetland vary considerably in size during the breeding season or even during the same night (personal observations), I do not consider detection of one or a few individuals during one brief visit an accurate indicator of size of the breeding population. I do, however, suspect that strong "roaring" choruses are indicative of large breeding populations. For example, at one such chorus in a small, wooded, roadside pond in Saline County, I observed a minimum of 100 calling males congregated on the north side of the pond. Males continued calling despite the presence of two human observers shining lights on them; no females were present. I heard crawfish frog choruses at 39 sites and strong choruses at five sites. Other frogs heard calling with crawfish frogs include American toads, *Anaxyrus* (formerly *Bufo*) *americanus*, spring peepers, *Pseudacris crucifer*, trilling chorus frogs, *Pseudacris feriarum–Pseudacris triseriata* complex, and southern leopard frogs, *Lithobates sphenocephalus* (formerly *Rana sphenocephala*).

Newly-discovered crawfish frog breeding sites—as revealed by Google Earth satellite imagery—include 1) large, shallow, constructed wetlands (surrounded by cropland or land recently retired from crop production); 2) ponds in cropfields, hayfields, pastures, or lawns (including recently-dug ponds and old ponds surrounded, or overtopped, by trees); and 3) flooded low areas in or on the edge of agricultural fields (one of which was confluent with a roadside ditch) or, in one case, in a cleared forest. Breeding sites were in rural agricultural settings; within small, rural communities; or in housing developments on the outskirts of growing communities. Some newly-discovered breeding sites were not pre-selected. These sites, often small and hidden from satellite view by trees, were discovered while traveling between pre-selected sites or after following calls heard in the distance while listening at pre-selected sites.

**Discussion**

The goal of this survey was to locate as many previously undetected crawfish frog breeding sites as possible during the peak of one breeding season and across a relatively large geographic area. To accomplish this goal, stops at/near individual potential breeding sites were, by necessity, brief, generally lasting no more than 1–5 minutes. As such, I may have missed crawfish frogs at sites where they were present, but not vocalizing at the time of my visit (crawfish frogs often call intermittently, especially at the beginning and end of the breeding season [personal observations]). In addition, time constraints prevented me from pinpointing the exact location of some breeding sites. Crawfish frog calls can carry up to 2 km under certain circumstances (personal observations) and determining provenance of calls can sometimes be difficult from the roadside, especially when multiple wetlands occur in the direction of the calling frogs or when it is impossible to get closer via, or triangulate from, another road. Surveying a smaller geographic area and/or fewer sites would potentially provide enough time to return to potential breeding sites where frogs were not detected, and to request permission to enter private property to pinpoint location of breeding sites.

Of the environmental parameters that may affect crawfish frog calling intensity and thus survey success, temperature, particularly air temperature, has received considerable attention. Smith et al. (1948), working in Williamson County, Illinois, wrote, "Air and water temperatures of about 10°C appear to be the critical optimum for *R. areolata*. Breeding activity does not begin until they reach about 8°C, and is not active until about 12°C. When well under way, the breeding activity lessens markedly by reduction of temperatures to 10°C, and virtually ceases at 6°C or less." Busby and Brecheisen (1997), studying crawfish frogs in Kansas, reported that (air) "Temperatures of ≥13°C appeared necessary for active chorusing, although sporadic calling was noted at temperatures as low as 8.0°C. " Parris and Redmer (2005), summarizing the literature and their own observations, stated that "Ambient air temperatures of 10–12°C (minimum 8°C) are critical to initiate and maintain breeding activity." Modeling of calling behavior in southern Indiana by Williams at al. (2012; 2013), indicate that crawfish frogs are best detected at air temperatures ≥8°C.

During my survey, I heard crawfish frogs calling (including chorusing) at air temperatures as low as 1°C. Of the 87 air temperature readings I recorded while listening to calling crawfish frogs, 30 (34.5%) were less than 8°C (mean of 5.3°C). Fifteen of these air temperature readings were recorded while crawfish frogs were chorusing. I attribute crawfish frogs calling and chorusing at low air temperatures to surveying on nights that followed relatively warm, sunny days (Table 1). I suspect water in breeding sites, heated by the sun during the day, was warmer than the air temperatures I was recording. This would allow crawfish frogs to be active and continue calling at air temperatures below that which is considered minimal for breeding activity or recommended for surveying.

My observations support the conclusion of Williams et al. (2013), who suggest that timing of sampling may be more important than air temperature. Although the probability of detecting calling crawfish frogs rises with an increase air temperature (Williams et al., 2012; 2013), my results indicate that auditory surveys conducted under cooler-than-recommended air temperatures can be productive. Doing so can increase the window of opportunity to detect this species. However, I recognize that longer and/or repeated visits to potential breeding sites, and surveying at higher air temperatures, may have resulted in the detection of crawfish frogs at a greater number of sites.

Crawfish frogs are of considerable conservation concern throughout their range (Stuart et al., 2008), and discussions to petition crawfish frogs for protection under the Endangered Species Act have begun (Williams et al., 2013). Efficient means of determining presence or absence of crawfish frogs during their abbreviated breeding season are needed. Pre-selection of survey sites directs surveyors to areas having the greatest potential to detect crawfish frogs, thereby saving time and potentially increasing the number of sites that can be visited in a single breeding season. Moreover, auditory surveys conducted under

less-than-ideal conditions can be effective at detecting calling crawfish frogs.

**Acknowledgments**

I *greatly* appreciate funds I received from the Chicago Herpetological Society that supported travel costs for the 2014 survey described here. This season's survey will go a long way towards completing my ongoing study of the current distribution and conservation status of the crawfish frog in southernmost Illinois. I thank Bob Bluett and Dirk Stevenson for providing letters of recommendation to the CHS grants committee, the CHS grants committee members for selecting my proposal, and the following individuals for sharing/clarifying locations of crawfish frog breeding sites in southernmost Illinois: Ronn Altig, Ronald Brandon, Mike Brown, Chris Evans, Amy Fairbairn Halsall, the late George Folkerts, Donovan Henry, Carl Koch, Chris Lechowicz, Bob Lindsey, Karen Lips, John Petzing, Mike Redmer, John Schwegmann, Jody Shimp, Dirk Stevenson, Rob Stroh, Terri Treacy, and Dan Woolard. Chris Evans and Rob Stroh—both of whom live near crawfish frog breeding sites—kindly contacted me when they first heard crawfish frogs calling and again when the frogs chorused strongly. I also thank Jean Sellar who accompanied me one night and Erin Palmer who accompanied me on six surveys, helped with the driving, and provided encouragement. Erin's assistance significantly facilitated this survey and is deeply appreciated.

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# Examining the Factors That Drive Migration and Road Mortality in a Leaf-litter Snake Population (Colubridae; *Storeria*)

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## Introduction

Direct road mortality is defined as the infliction of lethal bodily injury to an animal as a result of the construction and/or human-related use of a road surface. Lalo et al. (1987) estimated that approximately one million vertebrates die per day on the 6.4-million-km road network spanning the United States. In light of global amphibian and reptile population declines, studies that investigate small wildlife species in habitats dissected by road demand greater attention (Gibbons et al., 2000; Puky, 2006). Although background levels of road mortality brought about by random or tortuous movements through habitat are not considered detrimental to animal populations, the danger of mortality increases when high site fidelity or spatially disjunct resources override road avoidance behaviors (Andrews et al., 2006; Rouse et al., 2011). These intrinsic movement patterns stimulated by environmental variables persist despite the obstructive and potentially lethal presence of a roadway (Forman and Godron, 1981). For example, Ashley and Robinson (1996) observed over 30,000 amphibian roadkills in conjunction with seasonal migratory breeding patterns. These findings suggest that en masse migratory pulses put amphibian populations at the highest risk of road-linked decline (Glista et al., 2007). In certain emydid turtle populations, direct road mortality of migrating gravid females reduced fecundity and forced populations into a male-biased state with a limited effective size (Beaudry et al., 2010; Gibbs and Steen, 2005). Snake populations incur similar mortality, especially during seasonal activity peaks associated with breeding (Bonnet et al., 1999; Hartmann et al., 2011; Sheperd et al., 2008; Shine et al., 2004), egg-laying (Bonnet et al., 1999), and intervals of ingress and egress associated with overwintering (Seigel and Pilgrim, 2002; Shine and Mason, 2004). When these periods of movement occur during peaks in traffic intensity, the resultant mortality could impact population viability to a greater degree than either variable could independently (Fahrig et al., 1995; Lode, 2000).

My study examined the underlying factors that influence the occurrence and mortality of a population of midland brownsnakes (*Storeria dekayi wrightorum*) on an Illinois state park road. Individuals within this population make biannual migrations between lowland summer activity areas and upland overwintering sites. In order to successfully reach either habitat, snakes must cross a 2.4-km stretch of paved road. My study had two main objectives. First, I determined whether certain intrinsic (i.e., overall body size, gender, behavior) or extrinsic (i.e., temperature, season, traffic volume) variables affected brownsnake survivorship. Next, I employed a Geographic Information System (GIS) to examine whether snake movements across the road tended to cluster around certain habitat features along the road. I analyzed these data to better inform potential efforts to mitigate road mortality rates in this population.

I expected that size variables like body mass or size would not influence snake mortality for two reasons. First, even the largest recorded brownsnakes are small enough to be mistaken by a passing motorist for twigs or other road debris. And secondly, midland brownsnakes, like other species (Andrews and Gibbons, 2005), utilize a freezing defensive behavior when threatened. Adopting this sort of posture while on a road surface increases that individual's risk of death, regardless of the snake body size. I also expected that male snakes would incur higher mortality than females, on account of their propensity to move more in search of mates at certain times of the year (Ernst and Ernst, 2003; pp. 327-333). For this same reason, I suspected that male snakes would be less consistent in their movements across the road, thereby further increasing their chances of mortality. Moreover, I hypothesized that movement direction across the road would be best predicted by the season within the entire activity period.

Because the road and associated edge habitat do not serve either of the purposes of the adjacent ecosystems, I predicted that on-road encounter rates would peak during migration pulses. Next, I hypothesized that temperature and traffic volume will influence snake occurrence and mortality on the road, respectively. If my hypothesis is supported, then days where the temperatures best suited for brownsnake migration coincide with the highest vehicle traffic will result in the highest mortality rates for brownsnakes. Finally, I predicted that snakes would choose to cross the road at certain "hotspots," my term for points along the road associated with certain habitat types, or even scent trails laid down previously by other migrating brownsnakes.

## Methods

My study was conducted at Fox Ridge State Park (FRSP; Coles County, Illinois), an 835-ha land area composed of upland oak-hickory forests and lowland old fields and successional forests. The park also contains 8 km of paved road, with a 2.4-km section—Ridge Lake Road (RLR)—bisecting the two main habitat types (Figure 1).

Midland brownsnakes (*Storeria dekayi wrightorum*) are one subspecies within the *dekayi* complex, a group whose range extends from parts of eastern Canada, throughout the eastern US, and into some locations in Mexico and Central America (Ernst and Ernst, 2003). They are small, nonvenomous natricine snakes that are considered a part of the leaf-litter snake assemblage—a group of species that lead cryptic, fossorial lives.

**Figure 1** Aerial view of the northern 2.4-km stretch of Ridge Lake Road in Fox Ridge State Park. Shading corresponds to the relative number of midland brownsnakes encountered from October 2010 to November 2012. Intensity of shading is based on kernel density values estimated in ArcGIS (v10.1).

Brownsnakes generally prey on worms, slugs, snails, and other soft-bodied invertebrates. Although egress varies with latitude, central US populations usually emerge in late March- early April (Pisani, 2009). Brownsnakes are common across the United States, but their cryptic nature has made them a difficult species to study. Therefore, my study site is novel in that a large proportion of this population can be opportunistically encountered and captured on the road surface during highly synchronous migrations.

I surveyed RLR in two ways. First, I installed nine 100-m drift fences at 170m intervals on the uphill side of the road. These fences were constructed from 45-cm rolls of silt fencing material, and secured in the ground using wooden stakes and 1.27cm staples. These fences were augmented with an array of coverboards and pitfall traps. During the activity season, fences were checked once daily. To supplement this passive sampling method, I also conducted road-walking surveys to collect live and dead-on-road (DOR) snakes directly off of the road surface. Road-walking only took place during peaks in snake movement, specifically when using a vehicle to travel between fences 1) did not impair the accuracy of locating snakes on the road, and when it 2) did not add to the observed mortality data.

Upon encountering a snake, I noted whether it was alive or DOR (i.e., dead or dying-on-road). Next, orientation data was collected for live snakes both on the road and up against a drift fence. Since DOR snakes may have shifted in their orientation following a collision, I did not collect orientation from them. Next, I recorded GPS data for all live and DOR snakes; if snakes were within pitfall traps or under coverboards, I gathered GPS data as well as the specific code for that sampling object. All

live individuals were given a unique mark using a medical cautery unit, the proper procedure for which is described in Winne et al. (2006).

All live snakes and DOR snakes in good condition were taken to the lab for further processing. I measured mass (± 0.01g), snout–vent length (SVL) and tail length (TL; both ±1 mm). I palpated all snakes to determine the presence of stomach contents, and also the gravidity of female individuals. I determined gender using a cloacal probe to reveal the presence or absence of hemipenes. I collected daily traffic volume data from an Illinois Department of Transportation (IDoT) car counter installed at the start of RLR. Live specimens were captured under the authorization of IDNR permits, and were handled in accordance with IACUC guidelines.

All statistical analyses were done within SAS (vers. 9.2). Prior to any hypothesis testing, I ran the appropriate normality tests (PROC UNIVARIATE) on all response variables. Because of the absence of normality in the majority of my variables (Kolmogorov-Smirnov tests, $p < 0.001$), all statistical analyses in my study were non-parametric. I used a Kruskal-Wallis test (PROC NPAR1WAY) to assess whether size variables, like SVL or body mass, varied across survivorship, orientation, and activity season treatments. A similar procedure was used to investigate the shifts in temperature and traffic in relation to snake occurrence and mortality. Next, I used chi-square analyses (PROC FREQ) to investigate the effects of orientation across seasons, orientation across sexes, and mortality across sexes. Finally, a Kernel-density function within ArcGIS (v10.1) visualized the spatial clustering of snake movements across the road, and variation in clustering across seasons.

## Results

I captured a total of 124 individual brownsnakes in the spring, 39 individuals in the summer, and 1722 individuals in the autumn (2010–2012). My testing revealed that SVL ( $F_{1,1453} = 26.01$, $p < 0.0001$) and body mass ($F_{1,1397} = 36.72$, $p < 0.0001$) were significantly greater in female snakes; I also discovered that snakes with smaller body mass values had a higher incidence of mortality ($F_{1,1478} = 33.95$, $p = 0.0002$). That said, males brownsnakes in this study did also sustain higher mortality than females ($\chi^2 = 16.38$, $p < 0.0001$; Figure 2).

Next, I discovered that snake movements and their movement directions were significantly influenced by seasonality ($\chi^2 = 157.97$, $p < 0.0001$; Figure 2). Generally, snakes moved into the lowland areas in the spring, and towards upland habitats in the autumn. However, spring orientation trends were similar to those trends seen during summer months. Next, I discovered that gender had little influence on overall orientation trends either within (spring: $\chi^2 = 0.85$, $p = 0.36$; summer: $\chi^2 = 0.00$, $p = 1.0$; autumn:$\chi^2 = 3.5$, $p = 0.06$) or among seasons ($\chi^2 = 0.14$, $p = 0.71$). However, female movements in the autumn season tended to be more consistent than male or female movements at any other time of the year.

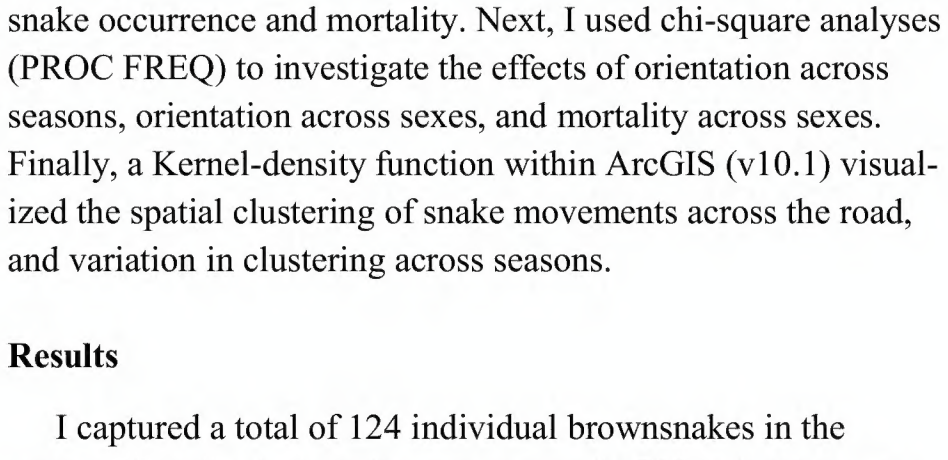


**Figure 2**. Mean direction of orientation (±1 SE) of live brownsnakes associated with the fence array or park road, observed between October 2010 and November 2012.

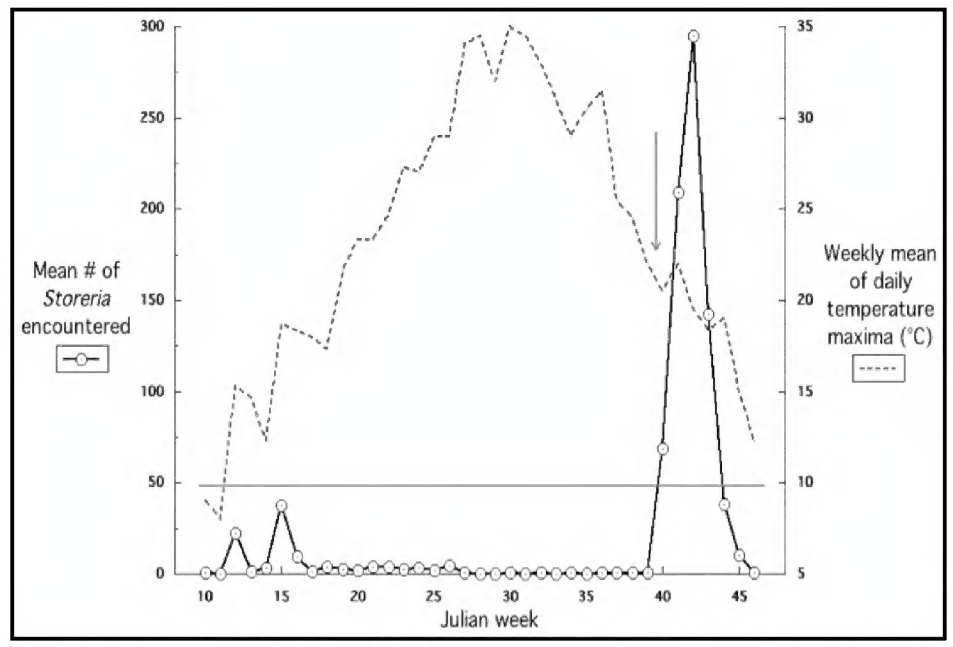


**Figure 3**. Weekly means of the number of brownsnakes observed (left y-axis) and daily high temperatures (right y-axis), during the activity periods from October 2010 through May 2013. The horizontal line represents the 10°C temperature minimum below which snakes were not encountered. The arrow indicates a drop in autumnal temperatures that might stimulate snake movements.

Snake encounter rates during autumn migrations were higher than during all other seasons combined (Figure 3). It appeared this increase in snake movements was accompanied by a shift in demographics; snakes migrating in the autumn were significantly smaller than those snakes encountered during the spring and summer months ($F_{2,1477} = 48.39$, $p < 0.0001$). Snakes also had lower survivorship during the autumn ($\chi^2 = 141.86$, $p < 0.001$; Figure 4); overall mortality coincided with higher traffic volume and drops in daily high temperatures associated with that time period (Figure 3).

## Discussion

My results indicate that a number of intrinsic and extrinsic ecological factors relate to the overall negative influence of roadways on this population of midland brownsnakes. First, I discovered that body mass, but no other size factor, influenced the probability of snake mortality. Brownsnakes have a diminu-

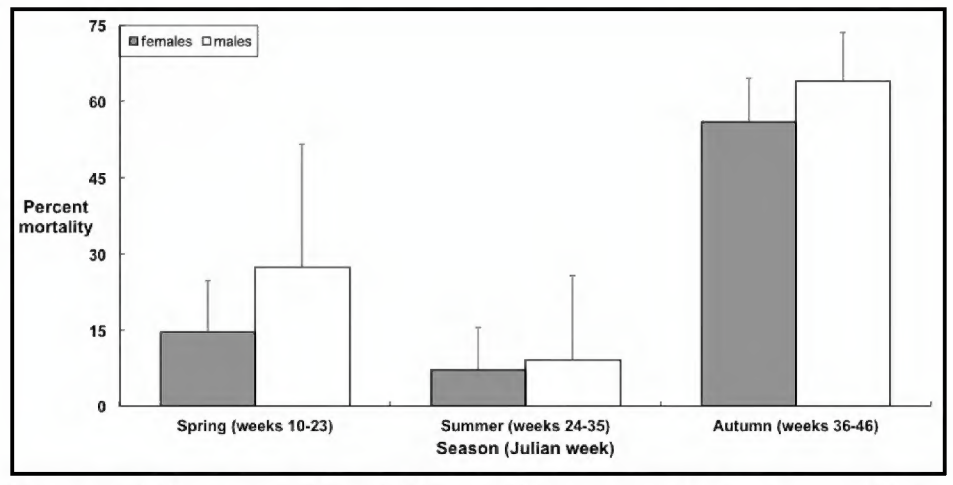


**Figure 4**. Mean percent mortality (±1 SE) experienced by brownsnakes encountered at FRSP from October 2010 through November 2013.

tive profile that makes them difficult to identify and avoid along a road surface, even among drivers inclined to do so. It is very likely that what is an improvement in size, in reality, might have very little biological influence on the snake's overall size or ability to flee from predators. When threatened, a brownsnake will often elicit a freezing defensive behavior. A common occurrence among small or cryptic species, this behavior is selected for in a natural context where predators often rely on visual cues to detect prey. In the foreign context of a road surface, freezing behaviors increase the amount of time a snake resides on the roadway, thereby increasing the chances of a vehicle collision (Andrews and Gibbons, 2005).

The direction of brownsnake movement was dependent on season, with snakes entering the lowland habitat in the spring, and migrating to the upland forests in the autumn (Figure 3). In the spring, snakes descend from the upland ridges and enter lowland areas containing wetlands and old fields, where substantial snail and worm populations sustain breeding adults and newborn individuals. Pisani (2009) reported similar findings for a brownsnake population that hibernated in forest edge habitat, then migrated to grassier and prairie habitats in the spring. Brownsnakes at FRSP benefit from the utilization of two distinct habitat types in the course of a single year. The innate drive to make migrations across a fragmented landscape might have originated at a time when no road barrier was present, which would explain their willingness to traverse an exposed road surface, thereby subjecting themselves to both natural and anthropogenic mortality risk (Bonnet et al., 1999).

The semiannual flooding that occurs in the lowland areas of FRSP could explain the persistence of annual migrations of brownsnakes towards upland hibernacula. Because these flooding events only inundate parts of brownsnake activity areas during the early spring, drastic population losses (Shine and Mason, 2004) would not be expected. Thus, direct road mortality is the most obvious threat to migrating brownsnakes at FRSP.

Snake encounter rates were higher in the autumn than in other seasons. One explanation for this pattern is the additional cohort of young-of-year individuals migrating for the first time into upland habitats. Variation in patterns of ingress/egress of adult snakes is another explanation. Female *Thamnophis s. parietalis* typically approach hibernacula using preferred migratory corridors, while dispersal during egress occurs in all compass directions (Shine et al., 2001). It is possible that brownsnakes at FRSP display similar dispersal responses prior to their migration into the lowland habitat. This type of behavior may allow females to acclimate to climatic conditions before mating or dispersing further. Further research in this system should attempt to identify brownsnake overwintering sites in FRSP so that patterns of post-emergence dispersal could be better understood.

Male brownsnakes incurred higher overall road mortality than their female counterparts (Figure 2). In general, this pattern is explained by male snakes having increased vagility when searching for mates, and therefore a greater risk of encountering a predator or other threat. Bonnet et al. (1999) and Hartmann et al. (2011) examined various mortality risks dependent on the amount of movement. They observed that snakes were at highest risk during long-distance movements outside of their home ranges. Sedentary snakes, therefore, were least threatened by natural or anthropogenic threats. Comparably, in the weeks preceding birth, gravid brownsnakes isolate themselves and immobilize (Clausen, 1936).

Brownsnake mortality on the road surface at FRSP was highest during the autumn migration - likely caused by the combined influences of temperatures promoting snake occurrence on the road and traffic volume on mortality (Figure 3). Previous studies on have demonstrated that snake mortality is correlated with temperatures that spurred snake movement, or with the interaction of temperature with traffic volume and habitat type (Ciesiołkiewicz et al., 2006; Sheperd et al., 2008). My experiments indicated that brownsnake mortality within the autumn increased when traffic volume was highest: during the weekends. Although high traffic volume occurring during large migration pulses can exacerbate mortality, its localized nature also offers opportunities to mitigate roadkills through various means.

Patterns of road mortality in my study system were shaped by topography and habitat formations on either side of the roadway. In FRSP, snake movements in the spring associated with a fair proportion of the drift fences. I expect that the optimal microhabitat found beneath coverboards made this passive sampling method most effective at that time period. During the autumn migration, however, movement clusters had shifted from the drift fences to areas associated with valleys or temporary streambeds that form corridors of low-slope topography. It is likely that brownsnakes follow these streambeds into the upland habitat, where they find appropriate microhabitat in which to hibernate. It is also worth noting that one of the two largest snake movement clusters along RLR was more closely associated with some riparian habitat nearer the Embarrass River than any other section of road (Figure 1). Amphibian and reptile corridors often overlap wetland habitats (Glista et al., 2007; Langen et al., 2007); At FRSP, brownsnakes may be utilizing wetter areas to feed on soft-bodied invertebrates prior to fall migrations.
My study has identified a number of factors—including seasonal, spatial, and sexual components—that influence road mortality in a little known species of leaf-litter snake. As a result of gender-driven variation in movement, male brownsnakes incurred greater mortality than their female counterparts. Snake encounter rates on the road as a whole varied with season, with periods of higher movement frequency occurring in the autumn, and in association with topographic cues. Because of their dependence on distinct habitat features, this population of midland brownsnakes traverses a road surface despite high mortality risk. After almost three activity seasons, 63% of snake encounters have been DOR individuals. Further investigation will determine whether this population can sustain itself in the face of large, annual mortality events. These findings might also apply to similar systems involving species of greater conservation concern in Illinois, such as Kirtland's snakes (*Clonophis kirtlandii*). Furthermore, where they occur in proximity to roads, future studies involving small-bodied snakes should consider road-related factors in their experimental design.

**Acknowledgments**

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# Pondering Poor Policy Planning, Problematic Protection, and Public Perceptions versus Proactive Programs for Marine Turtles

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Marine turtles are particularly hard hit by the environmental problems we create. Unlike pelagic fish and marine mammals, these creatures are not only dependent on our oceans, but they require places onshore to nest. Predator-free, undeveloped coastal sites are becoming scarce. The very beachfronts and coastal habitats used by the sea turtles for nesting are often overrun with tourists and their pets, recreational fishermen, and off-road vehicles during the nesting season. Still, in many ways, the land-based issues would seem easier to remedy than those of the sea.

Despite closing off and protecting key nesting areas many sea turtles continue to try to nest at sites of convenience. When eggbound females emerge from the sea they encounter seawalls, beach erosion, and late-night beach parties. At the height of the tourist season even relatively remote beaches often attract visitors taking evening strolls on the beach and four-wheel-drive vehicles loaded with fishermen. Successful nests can later be destroyed by recreational vehicles, and hatchlings may become entrapped in the tire ruts. Lights on rental cottages, beachside hotels and parking lots disorient the emerging hatchlings, directing them inland instead of toward the sea. Raccoons and other egg-eating creatures are typically present in abundance as a result of abundant food subsidies obtained from trash cans, unused bait, and fish heads left on the beach. Attempts to control raccoons sometimes backfire, because in modest numbers they help keep the ghost crab populations under control. Ghost crabs are notorious predators on hatchling sea turtles. When the raccoons are successfully eradicated, the crab populations explode. While the Endangered Species Act protects the turtles themselves, the law is rather lax when it comes to protecting the beach habitat. Managing competing recreational use for turtle needs often causes great conflict.

The issues facing marine turtles at sea are even more taxing, though for the most part they go unnoticed. During the BP oil spill an untold number of sea turtles died directly from contamination, as well as from loss, or contamination of food resources. Add to that the at-sea burning of oiled *Sargassum* that certainly harbored large numbers of young turtles[1]. Most marine environmental problems are more subtle than those caused by a widely reported oil spill. Mortality from ingesting plastic is common. Sea turtles frequently eat various items made of plastic that find their way into the sea. Even seemingly minor and harmless activities take their toll—birthday balloons that drift away on air currents to end up deflated, floating on the surface far at sea. These are also mistaken for food, and like the plastic, their ingestion can be fatal to marine turtles. Entanglement in fishing gear is an all too common problem; the turtles end up drowning. And we can add to this list boat strikes, chemical pollutants, and the loss of seagrass beds.

Marine turtles of course, are an international resource. While we can come up with all sorts of regulations, and well-intended

1. Based on estimated densities of young sea turtles inhabiting pelagic *Sargassum* communities (Marine Ecology Progress Series 463:1-22) compared to the standing crop of *Sargassum* in the Gulf of Mexico between 6 and 15 thousand young of the year and 36–77 thousand juvenile marine turtles were impacted by the BP/Deep Horizon spill.

plans for addressing their protection, the problems are multi-jurisdictional. In the Bahamas, for example, it is still legal to eat sea turtles and their eggs. These are the same species of turtles that occur offshore in our southeastern states. In many cases they are the same individuals, as they can be seasonally migratory.

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Can you say "fibropapillomatosis?" In recent years more and more sea turtles are being found with tumors growing on their necks and limbs. The floating, debilitated turtles are weak, often covered with algae, barnacles, leeches, worms or crabs. Blood work on rescued ones further confirms their poor health. The fibropapilloma tumors apparently are a result of the turtles' exposure to chemical pollutants that build up in warm waters of bays and lagoons where there is limited water circulation. It is informative to point out that the federal standards that are in place to protect marine environments, and us, from health-harming chemicals have not changed in the last 35 years.

By the late 1970s biologists studying marine turtles estimated that shrimp nets were responsible for drowning 12,000 sea turtles a year. This was just in U.S. waters. In June 1987 the National Marine Fisheries Service announced regulations requiring shrimpers in waters off the southeastern U.S. to rig their nets with turtle-excluder devices (TEDs), trap-door devices that allowed 97% of the turtles to escape from the nets without the loss of any shrimp. The Fisheries Service had actually come up with the device in the early 1980s, but it took years of pressure from various conservation organizations to force the government to require that they be used. The time lag between developing a solution and the "solving" of the problem resulted in the unnecessary drowning of an estimated one hundred thousand sea turtles.

Within a month after the regulations were announced the U.S. Senate delayed the implementation of the regulation. North Carolina and Louisiana sued the U.S. Commerce Department over the issue, resulting in even further delays in protection. Louisiana lost their case and turned around and passed a law making it illegal for state agencies to enforce any federal regulations requiring TEDs on shrimp nets. South Carolina passed a law in 1988 requiring TEDs on shrimp nets that are used within three miles of shore. The shrimpers then sued South Carolina's Wildlife and Marine Resources Commission twice, taking the issue all the way to the state's supreme court. The shrimpers lost, but their legal actions further delayed the passing of the federal regulations. Congress then delayed passing the TEDs laws while they waited for amendments to the Endangered Species Act. Louisiana sued again in 1989 and South Carolina passed legislation that prevented any state regulations that were stricter than federal ones. A crafty political move in that the federal regulations were still not in place. The delays proved costly, an estimated one thousand sea turtles a month died while all of this was in play. The revised federal regulations finally went into effect in 1990, but the excluders were now only required to be used from May through August. Drowned turtles continued to wash up on southeastern coastal beaches in the fall. It was not until 1992 that TEDs were required at all seasons. This was followed by issues resulting from the wording in the original requirements not addressing the size of the escape openings. Leatherbacks and large female loggerheads continued to drown in shrimp nets, and it took another year before the federal government redrafted the law requiring an opening that was large enough to accommodate the larger turtles.

The battles were not limited to legal issues. Waiting for the final rulings of agencies and courts, opponents of TEDs went to the front lines. Shrimpers hung sea turtle advocates in effigy, cursed the supporters at public hearings, and actually personally confronted some of the TEDs advocates with life threatening remarks. The tantrums of the fishermen protesting the over-regulation of the government resulted in the Coast Guard stalling on the enforcement of the use of TEDs. Governors made public statements downplaying the importance of marine turtle protection, and agencies responded by loosening and temporarily suspending regulations. Large numbers of drowned turtles still continued to wash ashore.

Eventually the shrimpers learned to like the excluders—not only did they resolve the turtle issues, but the openings allowed for trash, jellyfish, and other unwanted bycatch not to be mixed in with the shrimp. How many turtles needlessly drowned between the time they were first listed as endangered and when effective laws were finally in place? No one can know for sure. Studies conducted during this time suggested that less than one in four sea turtles that drowned in shrimp nets were washing up onshore, and only 13% of the dead beached turtles were found and reported. These reported numbers were used to compile seasonal and annual mortality: the actual number of shrimp net mortalities in the 25 years it took to get effective regulations in place can only be guessed.

A parallel situation developed in North Carolina in 1990 when it became obvious that considerable numbers of marine turtles were becoming entangled and drowning in gill nets set for flounder and other commercial inshore fishes. The initial focus had been on the fishery in Pamlico Sound. These turtles were covered under the Endangered Species Act and the Pamlico fishermen were required to obtain an incidental take permit in order to set gill nets. From reports of concerned citizens it became clear that state and federal agencies were not enforcing the regulations that related to this fishery, but it took well over a decade to resolve. A privately run local sea turtle rescue group became aware of the issue as growing numbers of dead turtles were being reported and numerous others in half-dead states were beaching and were being brought into the turtle hospital. In addition to letters and phone calls to the agencies in charge of turtles the group coordinated a campaign in which over 50,000 emails were sent to the federal and state agencies overseeing endangered marine turtles. There was no response. The problem continued to escalate and as expected the issue was not limited to Pamlico Sound.

There are over 2.5 million acres of coastal sounds and estuaries where gill-net fishing can take place in North Carolina. Marine turtles were drowning in nets throughout the state's coastal waters, but the incidental take permits were only required in one area, and even there the regulations were not being enforced. Between 2005 and 2009 as part of their incidental take permits the gill net fishermen of Pamlico Sound were required

to report any interactions with sea turtles and their nets. They reported zero. Neutral observers reported 156 known sea turtles caught in Pamlico Sound gill nets just in 2008. The objective was to limit the number of turtle entanglements and once an established number had been reached the fishing operation would be shut down for the remainder of the year. Obviously the self-reporting system was foolish: the fishermen were clearly not interested in compliance, and filing incidental take permits was certainly not a priority or felt to be in their best interest.

Opponents were quite vocal, and sometimes cruel in expressing their frustrations with environmental advocates and the agencies charged with overseeing the welfare of marine systems. In the late 1990s a number of articles appeared in local papers describing sea turtles with flippers cut off, porpoises with missing tails and pelicans with severed bills that had washed ashore. The mutilated creatures that were still alive were taken to various coastal wildlife rehabilitation facilities. Coastal fishermen tired of these creatures becoming entangled in their nets severed various body parts and tossed them back into the sea. Most, of course, bled to death or drowned. The few live ones that were recovered were emaciated as they were unable to feed. A nursing female porpoise was brought in that had net marks on her body and an amputated tail. That year the National Marine Fisheries Service reported that 64 bottle-nosed dolphins, all victims of fishing net entanglement, washed ashore in North Carolina in only two to three months. Today the target species seems to be mostly pelicans. Recently, there have been numerous reports of pelicans with smashed skulls and broken wings found along the beaches of southeastern North Carolina[2].

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Good regulations and effective enforcement are the government's tools for resolving conservation issues, but the private sector is also in a position to make important changes. Local programs that educate the public can become extremely effective. The Karen Beasley Sea Turtle Rescue and Rehabilitation Center of Topsail Island is a good case in point. Jean Beasley[3] founded the Center in 1996 to honor her late daughter Karen who was passionate about marine turtle conservation. While the focus of the Beasley Center is rescuing sea turtles with various aliments and releasing them back into the Atlantic once they are healthy, they have become an important educational center, informing residents, as well as tourists, of the various local conservation needs of sea turtles. Perhaps as important as the hundreds of sea turtles that they rescue are the thousands of people that they reach through their educational programs. The Center has a staff of 50 to 75 volunteers—mostly local people, many of whom have been working with the program since the beginning. On any given day during the summer they have over 350 visitors, and over 30,000 visitors come to the center each summer. The program is run entirely with private funding.

Jean Beasley's programs reach out to the local community as well. As a retired schoolteacher, Jean was aware of the value of integrated educational programs. In 2012 she worked with the Topsail Island Elementary School to develop a half-year program that integrated sea turtle biology and conservation into the art, music and math classes for all the students in K through 5th grade. At the end of the year the students prepared their own PowerPoint presentations for parents, family, and residents of Topsail Island. In the summer months the number of volunteers doubles.

As a result of Jean's efforts more than 150 people, including residents and tourists, patrol the beaches protecting nesting turtles, turtle nests, and later in the season, the hatchlings as they make their way to the sea. Occasionally hatchling loggerheads are found that went the wrong way; once 350 of these rescued turtles were marked prior to release, and were later reported in the Gulf Stream off New Jersey.

Local media regularly covers the Center's successes, and the residents of Topsail Island are proudly among some of the most adamant marine turtle advocates in the world. With increased media coverage, now even more sick and injured sea turtles find their way to the Center. Additionally, doctors and students from the veterinary school at North Carolina State University make regular visits to help with medical needs of the patients, and to check on their health prior to release.

The Beasley Sea Turtle Rescue Center teamed up with the Duke Environmental Law and Policy Center and prepared legal action against the government for their lack of action on the gill-netting mortalities. The suit they filed had strong backing because of the Beasley Center's effective use of media and the many years of educational outreach. The incidental take permit rule was doing little, if anything, to protect the turtles and the public was increasingly aware of this. It was clear that something needed to be done. Sea turtle advocates were unwilling to let the North Carolina Marine Fisheries Commission drag this out for another decade. The suit, filed in October 2009, centered on the obvious fact that the gill-netting regulations were out of compliance with the Endangered Species Act. The agencies responded, a court case was unnecessary, thus preventing injunctions and moratoriums on the gill-net fishery. No one expected zero mortality, but there were a number of points in the existing regulations that could be tweaked and the areas requiring incidental take permits, as well as the seasons and lengths of time gill nets could remain set, were amended. Opponents were not happy with the changes, and Beasley was shouted down in public meetings, and even threatened. Still, it was apparent that the majority of the public was behind her and the Center, and while the added protection the sea turtles received from the Division of Marine Fisheries was probably more public opinion-motivated than an actual interest in protecting sea turtles, it worked.

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State and federal governmental agencies are in fact addressing a number of important issues regarding the marine environment, but major problems with jurisdiction and enforcement continue. It is clear that a single person with the passion and drive to correct some of these major conservation issues can make a tremendous difference. The Karen Beasley Sea Turtle

2. Ironically, the gill net fishery has now temporally been closed due to the bycatch of red drum (a protected game fish).

3. In 2013 Jean Beasley won Oceana's Hero of the Oceans award.

Rescue and Rehabilitation Center located on Topsail Island in southeastern North Carolina does more than file suits. Jean Beasley's passion for sea turtles is contagious. Without use of any federal or state funds she has been able to educate legions of people, many of whom now take active roles in meaningful proactive conservation activities. Volunteers patrol beaches in the nesting season, protecting nesting females and escorting hatchlings to the sea. They mark nests to protect them from tampering sunbathers on blankets and from the tires of off-road vehicles. The beachfront community regulates its own back porch and street lighting, violations are reported, sick and injured turtles are brought into the shelter and dead ones are reported so that mortalities from fishery bycatch can be monitored. And today there are privately run seaside turtle hospitals carrying on similar conservation and educational oriented activities throughout marine turtles' Atlantic and Gulf nesting range. While the scientific studies and government protection are critical, there will always be people trying to discredit, and undo, everything when it comes to conservation priorities. It's the individuals with deep commitment and passions that in the long run will make the real difference. It matters little whether they are marine biologists, policy makers, or retired school teachers—they are getting the job done.

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On occasion laws on the books of governments in lesser-developed countries work to protect turtles, particularly when it can be demonstrated that there are financial rewards from conservation efforts that outweigh the profits made from exploitation. In 2009 a global study by the World Wildlife Fund on the economics of protecting sea turtle nesting beaches showed that tourism earned nearly three times as much money as local villages were making from the use and sale of turtle meat, leather and eggs. Locals saw the benefit of protecting the nesting turtles and the tide turned in favor of their conservation. In the Atlantic basin, where bycatch from fishing gear is not as severe as it is in the Pacific, leatherback populations are on the rise. Trinidad beaches support 80% of the leatherbacks nesting in the Caribbean, and over 15,000 females now nest there. By promoting turtle nesting, tourism jumped from 6,500 visitors in 2000 to over 60,000 twelve years later. The Trinidad-based Turtle Village Trust is now bringing in $8.2 million annually from tourism related to the nesting turtles. In northern Guyana leatherbacks are now the most common marine turtle, and in neighboring Suriname the nesting leatherbacks have increased tenfold. Puerto Rico has just protected a section of beach along its northeast coast that is used by more than 400 female leatherbacks a year. During surveys of 250 miles of Florida beachfronts over 500 nests were reported, and a few individuals are now nesting as far north as the Outer Banks. Not bad for a species that just two decades ago was one of the world's most endangered species.

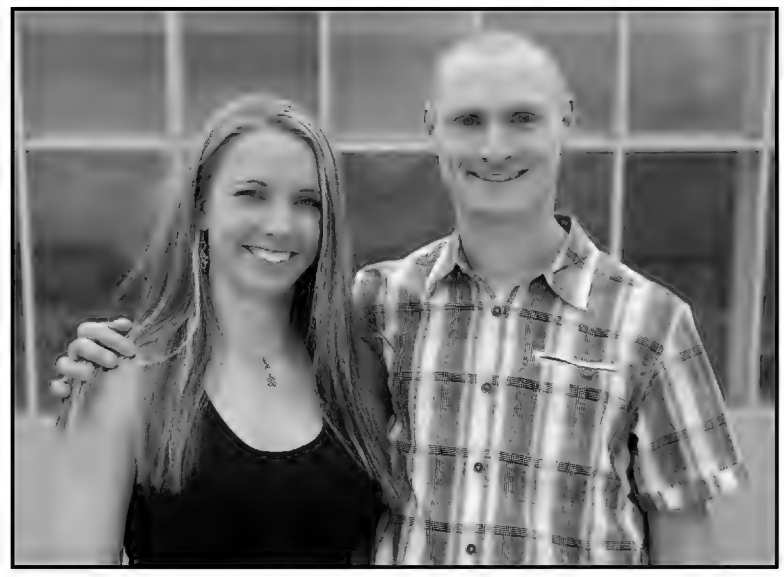
I recently read somewhere that in all likelihood we will go down in history as the generation that could have saved the oceans but chose not to. My fear is that this will prove to be true. Many continue to feel no personal guilt for what transpires in our marine habitats—even locally. Immediate needs and desires out weigh long-term consequences. Years back North Carolina's Pea Island National Wildlife Refuge posted an area heavily used by bird-watchers. The birders were checking tidal flats where migrating shorebirds were fueling up prior to migration on such a regular basis that the birds were constantly being chased off and were unable feed. The bird-watchers were mad, they saw the shorebirds as their birds, and felt that they should be allowed to disturb them. One well-known local birder was actually given a citation after he had been warned repeatedly to keep out of the area. In his own defense he demanded "How will we ever know what rare species are there if we can't get into the area?" Still, most of the problems are not blatant, spit-in-your-eye violations, but simply ones resulting from an uninformed public. We purchase frozen shrimp from major U.S.-based chain stores. These shrimp have been imported from Southeast Asia and are caught by trawlers that continue to drown dolphins and sea turtles. In fact, over 90% of the seafood consumed in the United States is imported. Most of the countries supplying these seafood products have few, if any, conservation policies in place. Most of us don't speak out when our regulatory agencies fail to strengthen policies or enforce laws intended to protect marine ecosystems. Jean Beasley summed it up rather well: "When you tolerate something, you empower it, and through inaction, you allow it grow." Wouldn't it be nice if resolving of marine conservation problems could be our generation's legacy? We could be remembered for uniting people and nations now separated by political beliefs, economic interest, and oceans.

*Bull. Chicago Herp. Soc. 49(5):70-72, 2014*

# What You Missed at the April Meeting

**John Archer**
**j-archer@sbcglobal.net**

I was really looking forward to our April speakers. I've known Sarah and Andrew Gilpin for a while. I've herped with them, dined with them, hiked with them, watched them photograph, toured with them, and laughed with them. The last is easy because they both have a great sense of humor, though Andrew usually goes the farthest to get a laugh, while Sarah will sit back and let him make a fool of himself. They are funny and fun, but deadly serious about the important things, like photography, and breeding geckos, and doing mudders (look it up if you've not heard that term), and physical fitness, and going rim-to-rim and back in the Grand Canyon in less than 24 hours. And giving presentations.



Sarah and Andrew Gilpin. Photograph by Dick Buchholz.

With great photographs, excellent timing, a little humor, and interesting anecdotes Andrew shared with us selections from two of their foreign adventures, one of which I was lucky enough to share. Sarah was supposed to share the speech, but we only had one microphone so she stood next to Andrew and made the occasional comment.

Andrew began with a brief survey of the camera equipment that each would likely carry. Their packs can weigh from 25 to 40 pounds. I've seen them carry those packs over very difficult terrain for hours through the night and well into early morning. Then a map highlighted the areas of Australia that they haunted for three weeks. During that time they slept in a hotel only two or three nights, the rest was camping in the car or tents. I know they know what luxury means; I just don't think they care too much about it. Two slides into the talk a picture of a White's treefrog (*Litoria caerulea*) sitting on a toilet seat graced our vision. The first herp they found in Australia, photographed in situ. After relocating the frog for better photographs, they returned it to the toilet, where they found another frog sitting in the same place. Apparently toilets seats are sought-after perches for White's treefrogs. Perhaps our captive breeders should take note. The photos continued. Andrew accompanied a photo of a frilled dragon with a amusing demonstration of how the lizards run and backed it up with a photo of a dragon running later in the talk. He mentioned that they are very strong and have vicious claws.

Colorful scenic pictures were occasionally interspersed among the very nice animal shots. Photos of a Burton's legless lizard (*Lialis burtonis*), and various geckos slid past our eyes. A photo of a giant cave gecko (*Pseudothecadactylus lindneri*) led Andrew to mention how a photo can remind you of specific instances. After day hiking three miles up and back in steep, rough terrain, they decided they'd do it again at night " . . . to see what we could find." That sentence was said very matter-of-factly and elucidates exactly why I can't keep up with them most of the time. The night hike allowed us a view of the brown and yellow gecko with gorgeous rusty-red eyes. File snakes (*Acrochordus arafurae*) and freshwater crocodiles (*Crocodylus johnstoni*), more geckos and more snakes were all displayed for our pleasure. The expression on Andrew's face while holding a northern spiny tailed gecko (*Strophurus ciliaris*) showed how excited he could be and, in a photo of Sarah holding a northern leaf-tailed gecko (*Saltuarius cornutus*), her nicely manicured nails showed that she maintains class even after three weeks of roughing it in the bush.

Multiple slides showed us the iridescence and large size of a scrub python (*Morelia amethistina*) and Andrew describes the

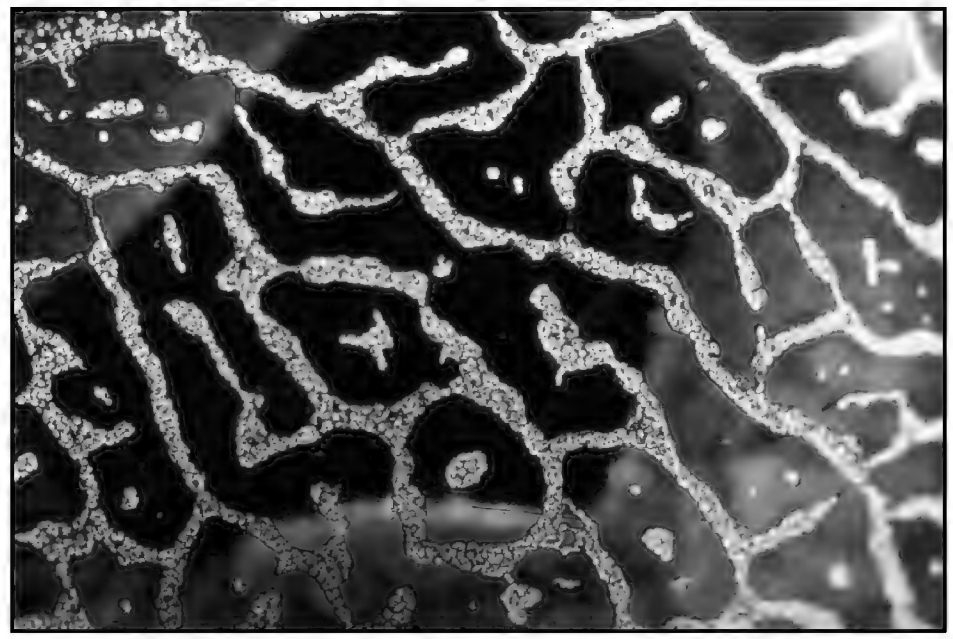
The natural habitat of White's treefrog (*Litoria caerulea*) in Australia. Photograph by Sarah Gilpin.

Australia's northern spiny-tailed geckos (*Strophurus ciliaris*) were some of the more exciting finds of the trip for the gecko-breeders. Photograph by Andrew Gilpin.

Nice nails on Sarah. Australia's northern leaf-tailed gecko (*Saltuarius cornutus*) is nice too. Photograph by Andrew Gilpin.

A striking photo from Ecuador of a Cope's vinesnake (*Oxybelis brevirostris*). Photograph by Andrew Gilpin.

The hard, sharp spines on Boyd's forest dragon (*Hypsilurus boydii*) could easily deliver a cut. Photographed in Australia by Sarah Gilpin.



Eyelid of a rusty treefrog (*Hypsiboas boans*). Photographed in Ecuador by Andrew Gilpin.

Ecuadorean two-striped forest pit viper (*Bothriopsis bilineata*). Photograph by Andrew Gilpin.

I'm always impressed by the heights Andrew will go to for a good picture. In the Ecuadorean Amazon. Photograph by Sarah Gilpin.

difficult and unique positions required to capture a haunting head-on shot of a brown treesnake (*Boiga irregularis*). Serendipity led to a nice photo of an eastern blue-tongued skink (*Tiliqua scincoides*), which Andrew said was much stronger and more aggressive than any in captivity. Revelations came at a rapid rate, even though I know that these two do their homework before venturing into new territories. Andrew was surprised that the dorsal spines of a Boyd's forest dragon (*Hypsilurus boydii*) were sharp and strong enough to cut. They finished Australia with a picture of a male red-crowned toadlet (*Pseudophryne australis*) guarding his eggs.

Then they took us to Ecuador. I was fortunate to have been invited along on this trip. I wrote a little about it when Bryan Suson talked to the CHS about Ecuador. I was anxious to see the superb photos of the Gilpins, and they did not disappoint. Once again they started with a map, and the first photo made clear the deep mud covering the nine-mile road to our first Ecuador location, the Mache-Chindul Ecological Reserve. Hiking in and out was a challenge for me, even though mules provided occasional relief, but the Gilpins, since they do mudders, must have felt right at home. Andrew's first shot was of a gray and white *Amphisbaena varia* that I happened to stumble upon shortly after beginning our hike in. That was followed by a photo of a blunt-headed tree snake (*Imantodes cenchoa*) coiled in a graceful lazy eight hanging by its tail. A prehistoric-looking rough teiid (*Echinosaura horrida*) was followed by a prehistoric-looking northern eyelash boa (*Trachyboa boulengeri*). Close-ups of the latter allowed us to appreciate the scalation and this snake's marvelous eyes.

Andrew claimed that Imbabura treefrogs (*Hypsiboas picturatus*) gained their Latin name from their tendency to always be found in a perfect photographic pose, and his photos certainly lent proof to his theory. Anoles and snail-eating snakes filled the screen. A tiny fly gave scale to a tiny marbled poison-dart frog (*Epipedobates boulengeri*) only about eight times longer than the fly. Andrew knows when to keep photographing, as shown by his series of a praying mantis photobombing shots of a brown forest racer (*Dendrophidion brunneum*). The snake remained still as the mantis strolled across its head, seemingly with the sole intent of getting star billing in the shot. A nice shot of a two-lined climbing salamander (*Bolitoglossa biseriata*) had Andrew mentioning that picking up these little salamanders would cause them to totally flip out and vigorously squirm. One must have a gentle touch to pose a *Bolitoglossa*. We saw striking poses of a Cope's vinesnake (*Oxybelis brevirostris*) and a rare shot of a caecilian consuming a huge worm; missing chunks on the worm were evidence of the violence of the caecilian's attack.

Pictures of a Surinam toad (*Pipa pipa*), mata mata (*Chelus fimbriatus*), and twist-necked turtle (*Platemys platycephala*) showed three difficult to find and normally well camouflaged animals that were discovered within a hundred feet of each other, along with a fer-de-lance (*Bothrops atrox*) and a tarantula (*Hapalopus* sp.) consuming a Troschel's treefrog (*Hypsiboas calcaratus*). The Gilpins provided a nicer picture of the treefrog a little later. That photo was the outcome of Andrew climbing about 20 feet up a three-and-a-half-inch diameter tree to catch the frog. We saw photos of a spiny dwarf iguana (*Enyalioides heterolepis*). Andrew informed us that these lizards have a "... pretty good bite on them." Naturally one of our group had to let this lizard bite him on the ear. It wasn't me, and sometimes I don't know why I hang out with these folks. Of course, stunts such as that are probably the reason. They're most dangerous when they're bored.

Glorious pictures of a smooth fronted caiman (*Paleosuchus trigonotus*) were followed by a slide of a young smoky jungle frog (*Leptodactylus pentadactylus*). The adults tend not to let one get close enough to photograph. And we were treated to photos of multiple color phases of Amazon tree boas (*Corallus hortulanus*). The talk ended with a group photo staged on a rise overlooking the expanse of the Amazon. The first was six of us looking like the intrepid explorers we hoped we were. Myself, Derek Dunlop, Andrew, and Sarah were flanked by our native guide Marco and our tour organizer, Bryan Suson of Biophoria Tours. Of course Andrew wouldn't settle for the standard shot, so the last photo was the same group as a "silly" shot. I really have to make a rule banning photos of me looking stupid.

As usual I can't recreate the Gilpins' presentation in a manner that does it justice. Andrew inserted a few facts, interesting tidbits, and often-hilarious anecdotes that perfectly accompanied the Gilpins' outstanding photography. It was a treat for me to relive the Ecuador adventure and a treat to experience the Gilpins' narrative of their Australian adventure. Two pretty cool people that I'm fortunate to know. You would like them too.

*Bull. Chicago Herp. Soc. 49(5):73-74, 2014*

# Herpetology 2014

In this column the editorial staff presents short abstracts of herpetological articles we have found of interest. This is not an attempt to summarize all of the research papers being published; it is an attempt to increase the reader's awareness of what herpetologists have been doing and publishing. The editor assumes full responsibility for any errors or misleading statements.

## PREDATOR AVOIDANCE BY AN ENDANGERED SALAMANDER

D. L. DeSantis et al [2013, Herpetologica 69(3):291-297] note that predation is a dominant and influential factor in most ecological communities. However, little is known about how the federally endangered Barton Springs salamander, *Eurycea sosorum*, responds to predators. Using captive-hatched (predator-naïve) salamanders, The authors examined the antipredator response of *E. sosorum* to chemical cues from (1) native western mosquitofish (*Gambusia affinis*), (2) introduced redbreast sunfish (*Lepomis auritus*), (3) native largemouth bass (*Micropterus salmoides*), and (4) a blank water control. Salamanders decreased activity (antipredator behavior) in response to all fish treatments but not to the blank water control. There was no difference between the response to the *G. affinis* and *L. auritus*, but salamanders responded less to these treatments than to *M. salmoides*. The antipredator response to *G. affinis* may be an ontogenetic holdover as *G. affinis* has been found to consume amphibian larvae and eggs. In an additional study to test whether antipredator behavior was a generalized response to all fish species, it was found that *E. sosorum* did not respond to small, nonnative, nonpredatory guppies (*Poecilia reticulata*). This suggests that the observed behavior in our first experiment represents antipredator behavior specific to the species tested. Overall, these results indicate that *E. sosorum* has innate recognition of predatory fish, and that the stronger antipredator response to *M. salmoides* over the other fish species may be an outcome of risk assessment. The antipredator response to *G. affinis* has management implications as *G. affinis* is sympatric with the largest population of *E. sosorum*, and may be consuming both eggs and larvae of these salamanders.

## PREY CHOICES OF TWO DWARF CHAMELEONS

L. Carne and G. J. Measey [2013, The Herpetological Journal 23(4):221-227] note that chameleons exhibit unique foraging behavior among lizards. They are classified as cruise foragers, an intermediate foraging mode between sit-and-wait and active foraging, but it is not known whether cruise foraging is seasonally adaptive. Seasonal changes in stomach contents and available prey were quantified for two dwarf chameleon species: *Bradypodion ventrale* from coastal thicket habitats and *B. taeniabronchum* from montane fynbos habitat. Around twice the number of invertebrates were available in the fynbos and thicket habitats during summer; moreover the volume of invertebrates available during summer was approximately double. The authors found that chameleons increased the number of food items in winter to equal summer stomach volumes, and these changes were particularly evident for the montane species *B. taeniabronchum*. Winter austerity was shown for both chameleons as they were more likely to take hard prey in winter, compared to summer when hard prey items were avoided.

## SHOWING RED

T. A. Baird et al. [2013, Herpetologica 69(4):436-444] note that sexually dimorphic coloration that plays a role in social signaling during stereotypical displays is well known in lizards. Previous studies on a large Australian agamid lizard (eastern water dragon, *Intellagama lesueurii*) documented male-biased sex differences in ventral coloration, but males were not observed to use postures that displayed their ventral surfaces. Male resource-holding potential (RHP) was determined by body size, with the largest individuals controlling territories in preferred riparian habitat. Both large males that defended territories and those that did not had fully developed ventral coloration. Together these observations suggested that male ventral coloration does not play a role in social communication in male water dragons. The authors tested this hypothesis by recording the behavior of free-ranging males during baseline social conditions and when the level of aggression was much higher because they temporarily removed and then reinstated territory owners. Male water dragons performed three behavior patterns that displayed their conspicuous ventral coloration when engaged in agonistic encounters with same-sex rivals, especially when social conditions among neighboring males were unstable. Rival males responded to these displays in all instances. A large, model water dragon male in which ventral color was manipulated elicited lower-intensity responses from rival males when the model ventral surface was red than when it was brown. This result is also consistent with the hypothesis that red coloration plays a role in signaling and perhaps in intimidation of rivals. Water dragon displays that revealed ventral coloration were not given when males interacted with females, suggesting red coloration does not function in advertisement to potential female mates. The results support the hypothesis that red ventral coloration in eastern water dragons functions in advertisement to rival males similar to the function of red coloration in several other vertebrates.

## EFFECT OF BAIT IN TRAPPING NEWTS

J. Baker [2013, The Herpetological Bulletin (124):17-20] reports that aquatic funnel traps (collapsible, mesh construction) set for newts were baited with beef and compared with non-baited traps. Baited traps captured great crested newts, *Triturus cristatus*, more than twice as frequently as traps with no bait, yielding more than three times as many newts. Females were more frequently attracted to baited traps than were male great crested newts. The addition of bait to traps did not significantly affect their efficiency in trapping smooth newts, *Lissotriton vulgaris.* Baiting traps is worthy of further consideration in great crested newt survey and/or surveillance work. Nevertheless, the trapping methodology described here is suitable only for specific conditions and is best regarded as an option within a range of survey techniques.

## DESERT TORTOISE DECLINES

K. H. Berry et al. [2013, Herpetological Monographs 27: 87-109] note that numerous factors have contributed to declines in populations of the federally threatened Agassiz's desert tortoise (*Gopherus agassizii*) and continue to limit recovery. In 2010, the authors surveyed a low-density population on a military test facility in the northwestern Mojave Desert of California to evaluate population status and identify potential factors contributing to distribution and low densities. Estimated densities of live tortoises ranged spatially from 1.2/km$^2$ to 15.1/km$^2$. Although only one death of a breeding-age tortoise was recorded for the 4-yr period prior to the survey, remains of 16 juvenile and immature tortoises were found, and most showed signs of predation by common ravens (*Corvus corax*) and mammals. Predation may have limited recruitment of young tortoises into the adult size classes. To evaluate the relative importance of different types of impacts to tortoises, the authors developed predictive models for spatially explicit densities of tortoise sign and live tortoises using topography (i.e., slope), predators (common raven, signs of mammalian predators), and anthropogenic impacts (distances from paved road and denuded areas, density of ordnance fragments) as covariates. Models suggest that densities of tortoise sign increased with slope and signs of mammalian predators and decreased with common ravens, while also varying based on interaction effects involving these predictors as well as distances from paved roads, denuded areas, and ordnance. Similarly, densities of live tortoises varied by interaction effects among distances to denuded areas and paved roads, density of ordnance fragments, and slope. Thus multiple factors predict the densities and distribution of this population.

## RINGED SALAMANDER DEMOGRAPHICS

R. D. Semlitsch et al. [2014, Herpetologica 70(1):14-22] give a detailed account of the structure and dynamics of five populations of ringed salamanders (*Ambystoma annulatum*) in Missouri over a 4-yr period. Average date of capture for breeding males varied from 30 August to 2 October, and average date of capture for breeding females varied from 9 September to 7 October. The sex ratio was consistently male biased and averaged 2.05 males to each female. The smallest breeding female was 77 mm snout–vent length ([SVL]; mean = 96.3 mm); the smallest breeding male was 66 mm SVL (mean = 94.2 mm). Eggs and larvae were present in September and October each year, and the larval period varied from 7 to 9 mo. Juveniles metamorphosed in all years in every pond, albeit in low numbers (6–631). The mean SVL of metamorphosing juveniles among all years and ponds was 39.2 mm. Intra-annual body size of emerging juveniles declined over time; juveniles that metamorphosed early were larger in body size than those metamorphosing later in the summer. Juveniles per female averaged 0.76 (range, 0.056–2.929), and survival of juveniles to metamorphosis averaged 0.2% (range, 0.01%–0.75%). Both females and males can reach reproductive maturity at 1 yr of age, but most return at 2–3 yrs of age. Management of thi salamander must focus on all life-history stages; protecting the aquatic stage to maximize the number and fitness of metamorphosing juveniles, managing the terrestrial habitat to maximize survival to first reproduction, and monitoring connectivity to promote metapopulation dynamics.

## AMPHIBIAN CONSERVATION IN BRITAIN

T. J. C. Beebee [2014, J. Herpetology 48(1):2-12] reports that agricultural intensification, starting during the Second World War, precipitated declines in all seven native species of amphibians in Britain. Problems in the United Kingdom (U.K.) therefore predated recognition of global amphibian declines and were due to relatively simple causes, notably habitat modification and destruction. Pesticides, acid rain, ultraviolet radiation, climate change, and disease have thus far proved relatively minor issues. Amphibian conservation started in the 1970s, initially with status surveys, but by the 1980s research into habitat requirements and proactive management was underway, particularly for the rare *Bufo calamita* (natterjack toad). The relatively widespread *Triturus cristatus* (great crested newt) was given the same legal protection as *B. calamita* in 1981 due largely to declines elsewhere in Europe. This protection has become problematic for conservationists on account of the many sites with this newt that regularly come under threat from development. Additional difficulties identified in the 1990s included serious impacts of road mortality on *Bufo bufo* (common toad) and inbreeding in urban populations of this species and of *Rana temporaria* (common frog). A previously unrecognized rare native, the "northern clade" of *Pelophylax* (formerly *Rana*) *lessonae* (northern pool frog) became extinct in the early 1990s but was reintroduced in the 2000s. In the past 4 decades conservation efforts have stabilized, although not increased, the U.K. *B. calamita* population, but some of the widespread species are still declining, albeit at a slower rate than in the postwar period. Effective methods for amphibian conservation are now available and the outstanding question is whether there will be sufficient funding to make greater gains in future.

## DEALING WITH FAST TEMPERATURE RISE

S. López-Alcaide et al. [2014, The Herpetological Journal 24(1): 41-47] note that the physiological performance of reptiles is subject to specific body temperature ranges, which are frequently similar between closely-related species even when they inhabit sites with different thermal conditions. Pregnant females should be particularly efficient for thermoregulation because healthy embryos develop at a narrow temperature range, a potential problem in the context of current global warming. To test the idea that pregnant lizards adjust their thermoregulatory behavior to rising temperatures, the authors set up an experiment with 40 pregnant *Sceloporus adleri* and measured daily activity and basking time at different treatments (22, 24, 26 and 28°C) for six consecutive days. Basking time significantly decreased with increasing temperature. Lizards were more active in the earliest two time periods of the day (0800–1030 and 1030–1300 hours) when compared to later hours (1530–1800) for all treatments, although the trend was less pronounced at 24 and 26°C. Unexpectedly, the probability of activity for lizards increased at 28°C. All lizards maintained a body temperature without significant differences across treatments. These results suggest that pregnant *S. adleri* females are able to adjust their behavioral thermoregulation to different thermal environments in a short period of time to maintain an adequate body temperature for key physiological processes such as development and growth of their offspring.

# Unofficial Minutes of the CHS Board Meeting, April 18, 2013

President John Archer called the meeting to order at 7:35 P.M. All board members were present.

**Officers' Reports**

Recording Secretary: Minutes of the March 21 board meeting were read. Changes were made, and the minutes were accepted.

Treasurer: The treasurer's report was given, discussed and accepted. Andy then gave a detailed ReptileFest financial report, showing good news!

President: John Archer thanked everyone for all their hard work on making ReptileFest 2014 a success. As a thank-you to Barbara Nieri-Hood for work above and beyond, Jenny moved and Mike Scott seconded, to reimburse Barbara for her vendor table cost. the motion passed unanimously.

Membership Secretary: Mike Dloogatch reported that we got 25 new members at 'Fest, as well as multiple renewals from existing members

Vice-president: Jason Hood also gave a 'Fest report, as committee chair. The weather was a factor in Saturday's lower than usual attendance, but numbers were very good on Sunday. Advertising and more media coverage were also discussed.

Corresponding secretary: Erica Mede is still working on getting the phone completely set up. The square reader is working and has been used for membership payments and T-shirt sales. She is working on a letter to solicit raffle donations.

Sergeant-at-arms: Attendance at the March meeting was 37.

**Committee Reports**

Shows:
• Notebaert Nature Museum, first full weekend of each month.
• Rockin' for the Reptiles, Midwest Museum of Natural History, Sycamore, Illinois, Saturday, June 28, 12–5 P.M.
• Westmont Pet Promenade, September.

Junior Herpers: 60 people attended the last meeting. Erica Mede will speak at the May 4 meeting.

Library: Teresa Savino is working on a library for the Junior Herpers, and continues to organize the CHS library.

**Old business**

Herp of the month: Any herp in an educational setting.

Website link: Erica gave a report on the Friends of Scales reptile rescue. After discussion, a link to Friends of Scales will be placed on the CHS website.

New Illinois herp laws: Senate Bill 902 is through the Illinois Senate, and is being amended. We will need to see it all in print before making the decision whether to endorse it.

**New Business**

Visitors from India: A former member currently living in India will be visiting May 1–5. Jason will work on coordinating a meeting with him.

New laptop: We need a new laptop to use with the projector at meetings. Aaron LaForge moved to purchase a new laptop. The motion passed unanimously.

**Round Table**

Rich Lamszus would like to see everyone at Junior Herpers meetings!

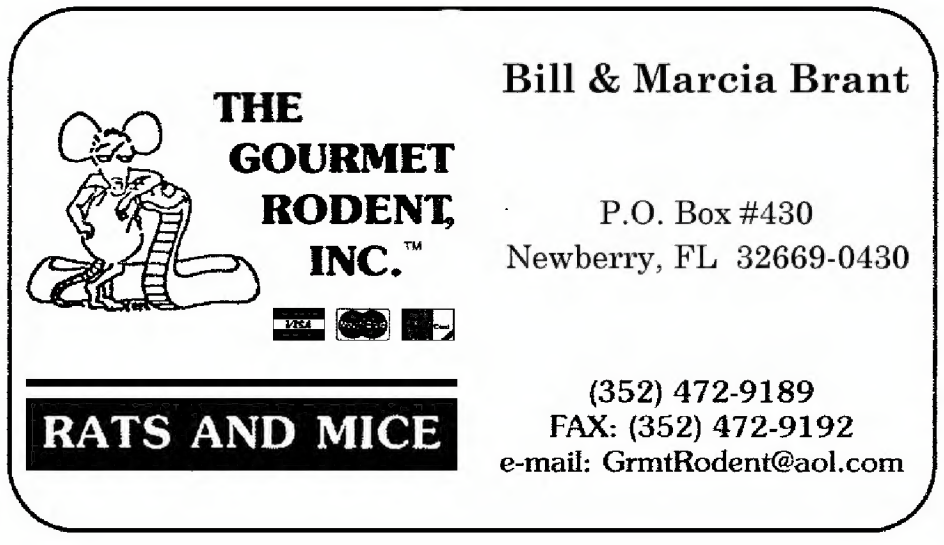
Rachel Fessler has 32 turtles to use at shows.

James Gardner will help at shows with Rachel.

Mike Scott reported that intrusive vegetation at the Sag Quarry Forest Preserve has been severely cut back.

The meeting was adjourned at 9:34 P.M.

*Respectfully submitted by Jenny Vollman*

# Advertisements

For sale: rats and mice—pinkies, fuzzies and adults. Quantity discounts. Please send a SASE for pricelist or call Bill Brant, *THE GOURMET RODENT*, PO Box 430, Newberry, FL 32669-0430, 352-472-9189, E-mail: GrmtRodent@aol.com.

For sale: **highest quality frozen rodents**. I have been raising rodents for over 30 years and can supply you with the highest quality mice available in the U.S. These are always exceptionally clean and healthy with no urine odor or mixed in bedding. I feed these to my own reptile collection exclusively and so make sure they are the best available. All rodents are produced from my personal breeding colony and are fed exceptional high protein, low fat rodent diets; no dog food is ever used. Additionally, all mice are flash frozen and are separate in the bag, not frozen together. I also have ultra low shipping prices to most areas of the U.S. and can beat others shipping prices considerably. I specialize in the smaller mice sizes and currently have the following four sizes available: Small pink mice (1 day old—1 gm) , $25 /100; Large pink mice (4 to 5 days old—2 to 3 gm), $27.50 /100; Small fuzzy mice (7 to 8 days old—5 to 6 gm) , $30/100; Large fuzzy mice / hoppers (10 to 12 days old—8 to 10 gm), $35/100 Contact Kelly Haller at 785-234-3358 or by e-mail at kelhal56@hotmail.com

For sale: High quality, all locally captive-hatched tortoises, all bred and hatched here in the upper Midwest. Baby leopards, Sri Lankan stars, and pancakes usually available, and are all well-started and feeding great! Leopards are $125 ea., Sri Lankans (2012 hatched) $475 ea. And Pancakes are $195 ea. Leopards for out of state sale/shipping require a veterinary health certificate (inquire for cost). E-mail at KKranz1@wi.rr.com or call Jim or Kirsten at 262 654 6303.

Herp tours: **Costa Rica herping adventures**. Join a small group of fellow herpers for 7 herp-filled days. We find all types of herps, mammals, birds and insects, but our target is snakes. We average 52 per trip, and this is our 10th year doing it. If you would like to enjoy finding herps in the wild and sleep in a bed at night with air-conditioning, hot water and only unpack your suitcase once, instead of daily, then this is the place to do it. Go to our web-site http://hiss-n-things.com and read the highlights of our trips. Read the statistics of each trip and visit the link showing photos of the 40 different species we have found along the way. E-mail at jim.kavney@gmail.com or call Jim Kavney, 305-664-2881.

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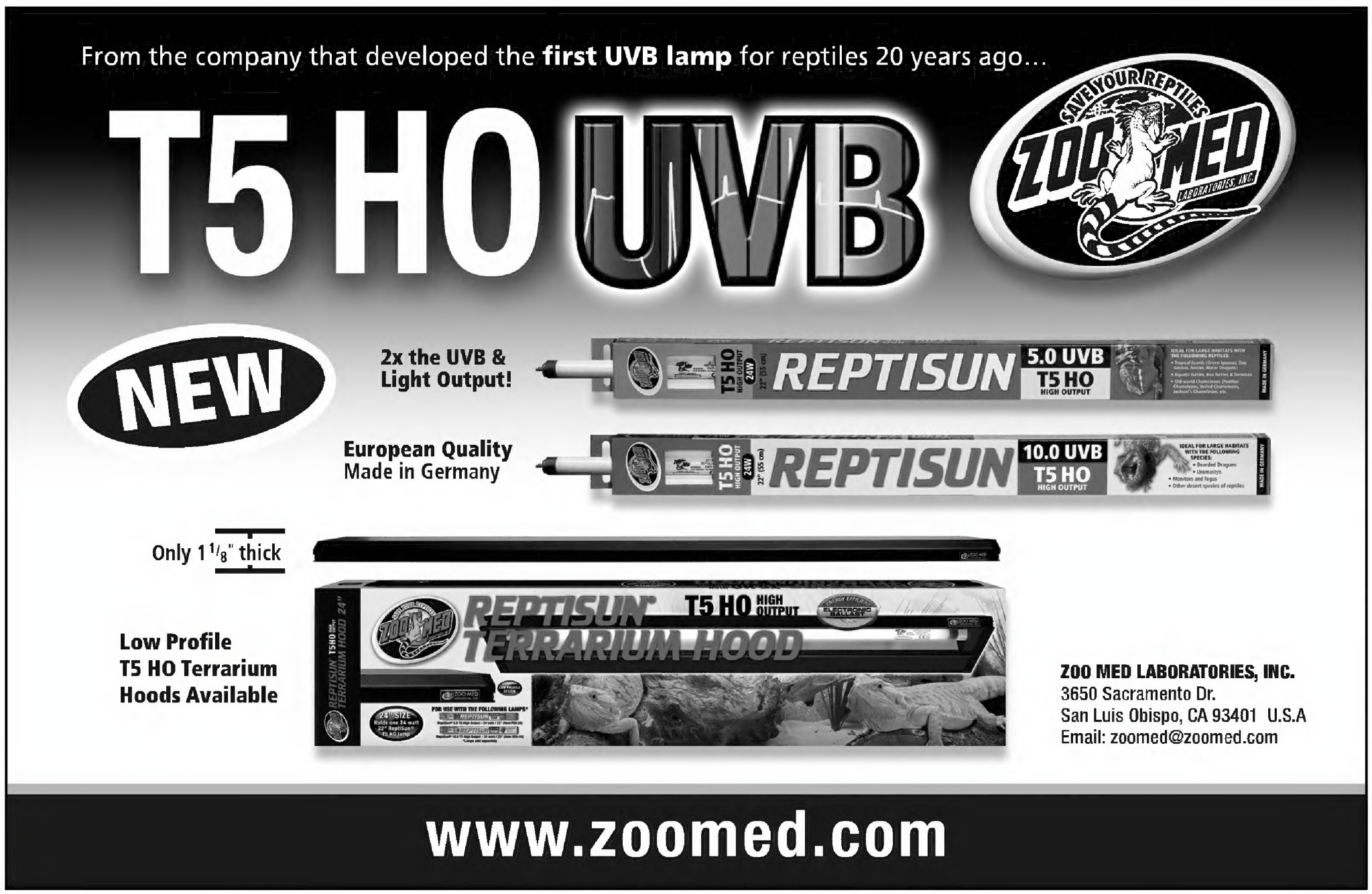


## UPCOMING MEETINGS

The next meeting of the Chicago Herpetological Society will be held at 7:30 P.M., Wednesday, May 28, at the Peggy Notebaert Nature Museum, Cannon Drive and Fullerton Parkway, in Chicago. **Kristen Wiley and Jim Harrison**, of the Kentucky Reptile Zoo, will give a program titled "Venomous Vacation: KRZ Visits Sri Lanka." This presentation will describe Jim and Kristen's trip to Sri Lanka, where they worked with the Sri Lankan AVRI team to set up a venom production serpentarium and produce the very first venom to be used in antivenom production for the country.

The June 26 meeting will be our popular and always well-attended annual **Show & Tell** meeting. Bring an animal that you find interesting for one reason or another and be prepared to give a short (under five minutes) presentation to the group. Don't be shy. Neither age (yours) nor commonness (the animal's) should be a limitation.

The regular monthly meetings of the Chicago Herpetological Society take place at Chicago's newest museum—the **Peggy Notebaert Nature Museum**. This beautiful building is at Fullerton Parkway and Cannon Drive, directly across Fullerton from the Lincoln Park Zoo. Meetings are held the last Wednesday of each month, from 7:30 P.M. through 9:30 P.M. Parking is free on Cannon Drive. A plethora of CTA buses stop nearby.

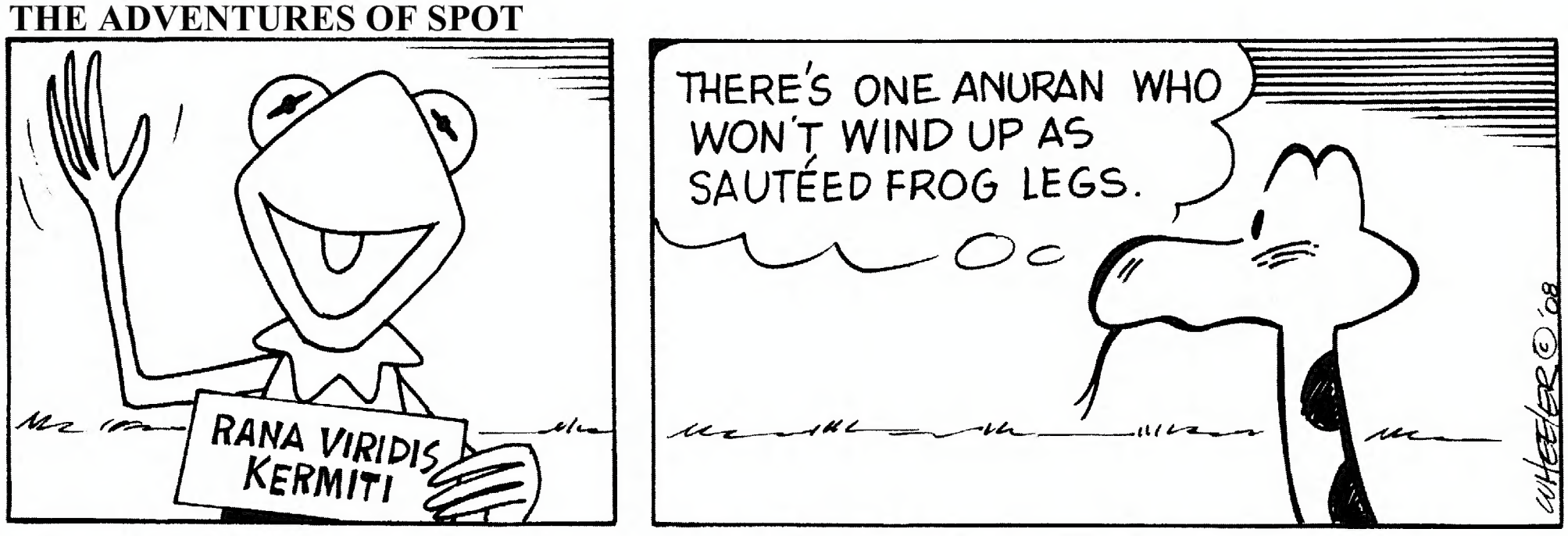
### Board of Directors Meeting

Are you interested in how the decisions are made that determine how the Chicago Herpetological Society runs? And would you like to have input into those decisions? If so, mark your calendar for the next board meeting, to be held at 7:30 P.M., June 13, at the Schaumburg Township District Library, 130 S. Roselle Road, Schaumburg..

### The Chicago Turtle Club

The monthly meetings of the Chicago Turtle Club are informal; questions, children and animals are welcome. Meetings normally take place at the North Park Village Nature Center, 5801 N. Pulaski, in Chicago. Parking is free. For more info visit the group's Facebook page.

### THE ADVENTURES OF SPOT



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